TEXTILE RESEARCH

Publication of Textile Research Institute, Inc., and The Textile Foundation

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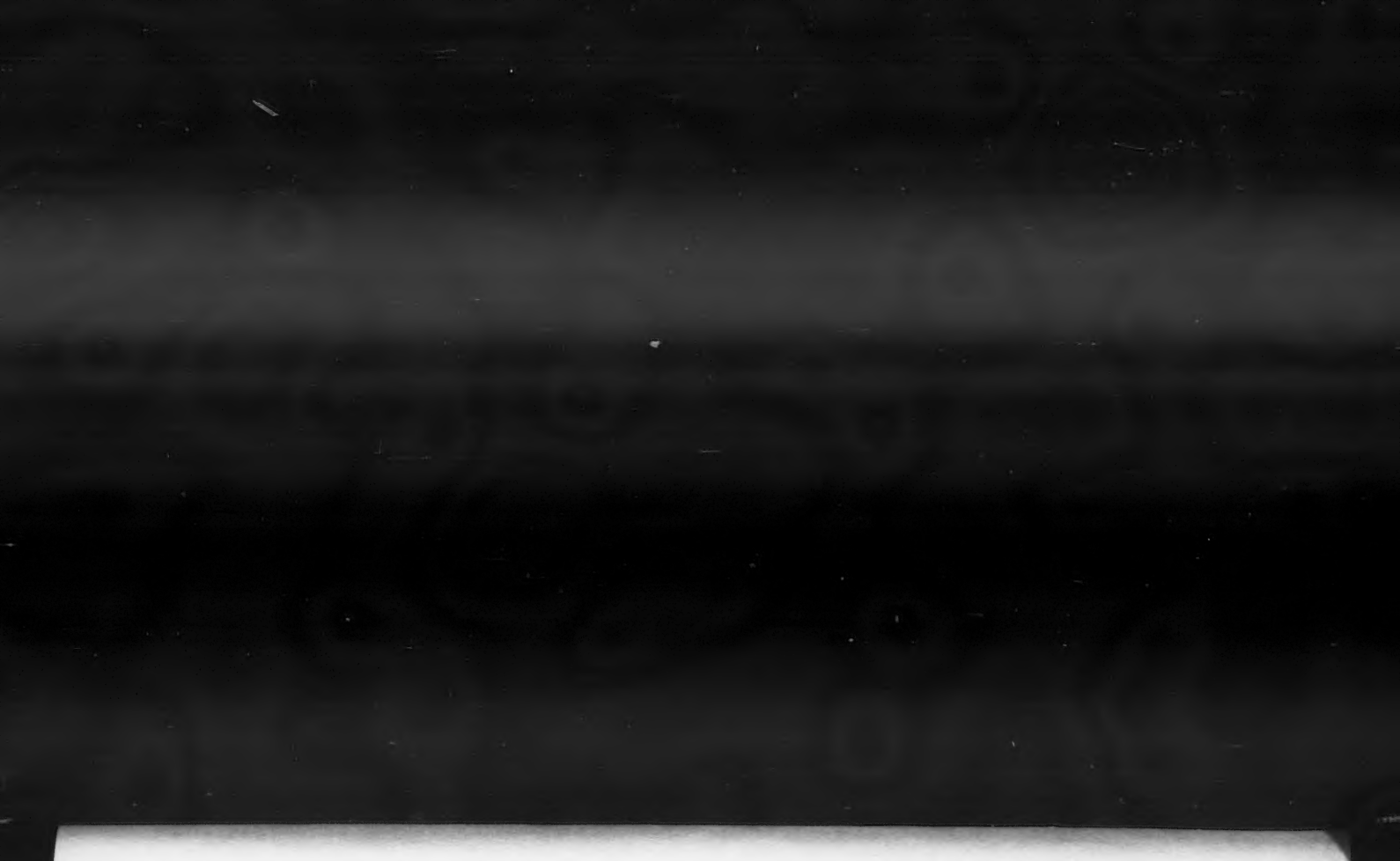


In This Month's Issue

The Institute's Expanded Program

An outline of the expanded program of Textile Research Institute, Inc., has just been published in booklet form. (See page 98.)

★ ★ ★

Post-War Company Research Requires Elimination of Air Tight Compartments

To do an effective job in its own research program, and to utilize effectively the products of industry-wide research, an individual textile company will require a higher degree of internal coordination in the post-war period than ever before. (See page 99.)

★ ★ ★

Reactions from Readers

The article "Research is the Only Sure Prediction for an Unpredictable Year" which appeared in the January issue of TEXTILE RESEARCH has attracted many favorable comments from readers. Some of these letters have added constructive suggestions which amplify the thoughts expressed by the author of the article and will be of interest. (See page 100.)

★ ★ ★

The Dynamics of Flowing Cords

There is a direct analogy between the principles governing the behavior of transmission belts and ropes and those applying to the handling of ropes of cloth in the textile finishing plant. This knowledge should lead to improvements in the design of cloth handling apparatus. (See page 105.)

★ ★ ★

Alkyd Resins in Textile Finishes

The technical and patent literature bears out quite definitely the fact that alkyd resins are rapidly finding many uses in the textile industry to impart special qualities to textile materials. (See page 116.)

Textile Research Institute, Inc.
Publishes Outline of

The Institute's Expanded Program

An outline of the expanded program of the Textile Research Institute, Inc., has just been published by that organization in booklet form under the title "A New Opportunity for All Textile Men Through Research."

After stating the need which faces the textile industry, the booklet states that the choice between the alternatives of failure and survival lies through research. It high-lights particularly the public interest phase of industrial research.

An important section of the booklet dispels the confusion that has arisen in the minds of textile manufacturers due to the emergence of several new textile research groups. It arranges these by patterns, explains their primary functions, and orients them in relation to each other and to the field of textile research as a whole. "The impression has been created that a lot of new organizations have sprung up over-night to bid for the textile manufacturer's dollar, for identical purposes," it is stated. "Actually, the amount of basic duplication in the field is amazingly small." This section concludes with an outline of the functions of the Textile Foundation, with which the Textile Research Institute, Inc., has a close working arrangement.

Coming to the program of the Institute itself, the booklet details its five major phases: fundamental research, applied research, economic research, graduate training, and research information service. It emphasizes the Institute's recently-announced decision to establish its laboratories at Princeton, N. J., as soon as feasible, and to concentrate there its research work and graduate training. This decision was hailed by President H. W. Dodds, of Princeton University, as "in the best tradition of Princeton as a center for education, scholarship and research."

After fully developing the theme of what this expanded program means to a textile manufacturer, the booklet shows how each manufacturer can participate: by presenting the details of the Institute's financing plan, and the privileges of the different types of membership.

Another section answers the questions: "What can my company expect for its money?"; "Will the Institute do research in my branch of the industry?"; and "What does a member get which non-members do not get?"

Also included is information about the personnel and present membership of the Institute, and the tax status of research expenditures.

Copies of the booklet may be secured on request from the Textile Research Institute, Inc., 10 East 40th Street, New York 16, N. Y.

Post-War Company Research Requires Elimination of

Air-Tight Compartments

By **DOUGLAS G. WOOLF**

To do an effective job in its own research program, and to utilize effectively the products of industry-wide research, an individual textile company will require a higher degree of internal coordination in the post-war period than ever before. This means coordination not only of the organization itself, but of the executive thinking of the company.

Trite as this statement may seem, it is one of those sound ideas to which too often only lip service is given.

The job should start in the zone of executive thinking. There is an innate tendency to concentrate on one problem at a time and to subordinate other major phases for the time being. Thus we have had waves of recurring emphasis on production technique, or on merchandising, or on industrial relations, or on raw material requirements —each to the temporary exclusion of the others.

To prevent this isolation of one phase at the expense of others, is the primary responsibility of the chief executive of a company. The job of coordination cannot be delegated.

However, to enable him to do it best, it is necessary to set up an organization which is constantly thinking in terms of the real objective: the production of goods which will best meet the requirements of the consumer, whether it be an intermediate or an ultimate consumer, and to do this profitably for the company and its employees.

This means that whatever air-tight compartments may have existed in the past—and they develop often unconsciously and without any encouragement—must be eliminated in the post-war period. The production department, the sales department, the personnel department, the research organization, must all be geared to a realization of the relation of each to the others.

This is not an easy trick—as any manufacturer knows from experience. But it can be done—and it must be done.

The best help which the chief executive can get in his job as coordinator is through a series of frequent and regular conferences among the key men of these and other major departments. There is sometimes a tendency to belittle conferences, mainly because there are often so many unnecessary ones. A great deal of time can be lost in certain types of committee activities. But this coordination conference idea, if properly executed, is not one of the expendable kind.

Particularly is the synchronization of the research program, whether it be technical research or product research, vital in a period of flux such as the years after the war are sure to be.

It is probably the basic key to the utilization of research.

Reactions from Readers

The following are a few of the comments received from readers in connection with the article "An Unpredictable Year" which appeared in the January, 1941, issue of TEXTILE RESEARCH. *They are presented here because of the additional thoughts they offer on the complex outlook in textiles.*

★ ★ ★

"I have read carefully every word of your article and it seems to me you have presented the matter of research again in all of its aspects. I think your article is especially timely. We seem to have broken out in a rash of research programs in the last year or so, out of which no doubt will come in time a coordinated effort without overlapping. I think that we must have not only overall research effort but individual research effort to fit in with the capacity and the limitations of the individual mill and I think we have got to have more and better research by the textile machinery people.

"I believe the most important observation you made was the one in next to the last paragraph. That is, that the economic problem will be bigger than the technical problem and that improvements can be benign or potentially malignant. I think we are going to have to have a lot of research on the economic as well as the psychological questions following this war."—W. S. NICHOLSON, Treasurer, Darlington Manufacturing Co.

★

"I have read your article with keen interest and I thoroughly agree with you that it is an unpredictable year and, as a matter of fact, I think that any attempts at definite predictions are just foolish until the chaos of war is past and the reconversion period entered into. We can simply operate to our maximum with short looks ahead.

"This does not mean that we should not attempt planning for the post-war era but these plans should be extremely flexible.

"Your reference to trade associations is both timely and appropriate and I am personally convinced that trade association executives will need to exercise leadership to a far greater degree than they have in the past. It is true that many of our present Government agencies do not approve of the activities of trade association executives and prefer not to cooperate with trade associations. It is my conviction that this has hampered the prosecution of the war but the odium must be placed with the Government and not with the associations. If this conclusion is right, and I think it is, then the thing to do is to change the controls and place industry and their representative groups in their proper position."—FRANK E. SLACK, President, Association of Cotton Yarn Distributors.

★

"I think this is a very good summation for the cause of research; however, I think I would add one additional point and that is the question of trained manpower.

"I am thoroughly in agreement with the idea of blending of fibers and I think I have expressed myself in this respect to you, that there will not be any particular battle of the fibers, but a much more intelligent study of fiber

properties in order that they may be used more successfully together. New finishes, new machinery developments and certainly economic changes are as certain as tomorrow morning's sunrise. The textile industry is waking up to the need of some of the textile schools, as evidenced through the various foundations that have been established and are in the process of being established. It is going to take more than money; it is going to take the time, advice and counsel of some of the best brains in the industry to see that these various textile schools select or have an opportunity to select equally among entering students in colleges; that these boys are given the finest possible training, and that after completing their college education they be given an opportunity to prove themselves in a friendly atmosphere that recognizes that trained manpower is going to be necessary to cope with these changes that lie ahead of us."—M. Earl Heard, Director of Research, West Point Manufacturing Co.

★

"Your counsel to the textile industry in the January number of Textile Research is well founded, of course, but the section relating to the economic outlook is to my mind the most to be heeded by the industry.

"That is not being defeatist in my point of view, as I feel that if the industry improves its product and improves the methods of producing it so as to bring down the cost per unit as low as possible, we are more than equipped to meet world competition.

"On the other hand, the textile industry's record shows that it is quick to adopt more efficient production methods but slow to study *where that production will be absorbed.*

"I wish you could print the last few paragraphs of your article in very large type in every issue of Textile Research for the next year."—Irene L. Blunt, Secretary, The National Federation of Textiles, Inc.

★

"I find myself in agreement with your views concerning the role of research in the textile industry. To my mind there is little doubt that research will play an important role in determining the relative position of the old and new fibers in the post-war market. Research will obviously play its part also in determining the type of processing equipment to be used.

"I think you are correct in stating that the economic problem facing us in the post-war period in the textile industry, and for that matter in all industry, overshadows the magnitude of the technical problem. Because of the many unpredictable variables that will affect business conditions, it seems hazardous to estimate one's post-war position at this time."—P. S. Wilcox, President, Tennessee Eastman Corporation.

★

"I certainly agree that research is vitally important to the textile industry, and it is going to be very much more important after the war than it has ever been before. I think it is most urgent for the textile industry to have some kind of an Armistice plan ready for immediate action, and a post-war plan to follow it. I feel that the industry should take steps now to take advantage of all the new developments in military fabrics and new ideas so as make them useful after the war."—Frank L. Walton, Vice-President, Catlin Farish Co., Inc.

RESEARCH ACTIVITIES

The Classified Directory, Eighth Edition, 1944, issued by the Association of Consulting Chemists and Chemical Engineers, Inc., 50 East 41st Street, New York 17, N. Y., lists many consultants and engineers in varied fields and also describes the qualifications and kinds of service that they and their organizations are prepared to render. The Association acts as a clearing house for consultants and furnishes, as a free service, upon request, the names of consultants specializing in any given field.

Preshrinkage tests of wool hose are being conducted at the Philadelphia Quartermaster Depot. Various chemical methods including recently developed processes are being tested. It is thought that damage has some times been caused by the use of excessive alkali in scouring operations. Therefore the possibility of preshrinking wool socks by chemical methods as opposed to getting preshrinkage in the scouring operation has aroused some interest.

The annual spring outing of the Philadelphia Section of the American Association of Textile Chemists and Colorists will be held at June 16th at the Cedarbrook Country Club.

Silk production and sericulture are being given serious attention in Latin America according to a report by the Coordinator of Inter-American Affairs. The industry in Brazil has been subsidized since 1923 by the Brazilian government and it is reported that considerable increase in production is in progress. Argentina established a Division of Sericulture in 1942. Cuba, Nicaragua, Chile and Mexico also have experimental programs under way.

Wider development of permanent adherent finishes was predicted by Dr. Anthony M. Schwartz, research director of the Alrose Chemical Co., at a recent meeting of the Rhode Island section, American Association of Textile Chemists and Colorists. Dr. Schwartz based his forecast on the increasing knowledge of the factors affecting substantivity and adhesion, emphasizing the close analogy between the surface adhesion of finishes and substantivity of dyes.

The development of an electrochemical compound is announced by the National Oil Products Co., Harrison, N. J. It is especially recommended for use on fabrics of hair and wool mixtures, cotton, and synthetic fibers, particularly for such fabrics as velours, velveteens, blankets, flannels, etc. It is said to impart a softness and loft to napped goods and enables the fibers to yield to the action of the napper without being pulled out or broken. The company reports that it reduces static and fly during napping.

A new method for testing the content of wool in grease will be used for the first time commercially in testing the 1944 clip. This announcement was made by Dr. Alexander Johnston of the Department of Agriculture in a

recent discussion before the subcommittee of the House Agriculture Committee. The new system consists of using a special machine for extracting a core of wool at random from the center of the bag. The samples will be gathered by field crews and will then be scoured and tested.

A new composition for producing electrically conductive coatings for cloth, plastics, glass, and other nonconductors has been developed by Du Pont. The product contains silver powder.

A fireproof compound has been developed by United States Rubber Company to be used as a coating on a fireproof base fabric. An immediate use is in fireproof berth covering for boats, adopted as standard equipment for Navy vessels. It has excellent resistance to high temperature without becoming soft and tacky and also has been tested to minus 40° F. without cracking when sharply creased. It resists oil, gasoline, and salt water.

Winn W. Chase, newly appointed director of technical publicity and market research for the Aridye Corporation, Fair Lawn, New Jersey.

Winn W. Chase has resigned as executive editor of *Textile World* to become director of technical publicity and market research for Aridye Corporation, Fair Lawn, New Jersey. He will supervise these activities of the company, including the investigation of markets for new products and the study of the postwar needs of those branches of the textile industry served by Aridye Corporation and associated companies. Mr. Chase specialized in chemistry at Brown University and served in the Chemical Warfare Service during World War I. In 1929, after 10 years of experience in the textile industry, much of it with Mount Hope Finishing Company, he joined the editorial staff of *Textile World*. As technical editor, and more recently executive editor, he was responsible for for the major share of the publication's editorial content. He is the author of numerous articles dealing with the technical and economic aspects of the textile bleaching, dyeing, printing, and finishing industry, and is a contributor to the Encyclopaedia Brittanica and Collier's Encyclopaedia. Mr. Chase is a member of the American Association of Textile Chemists & Colorists, the Society of Dyers & Colourists (England), the American Association of Textile Technologists, the American Society for Testing Materials, and the Textile Research Institute, Inc.

Research Programs Must Be Based Upon Adequate

Surveys of the Technical Literature*

The problem of the research scientist is today more complicated than ever before. He must invent bigger and better inventions in less time and under all the disadvantages of war-time restrictions on personnel, materials, etc. Much could ordinarily be accomplished by placing increased time and emphasis on a careful analysis of the technical literature. Despite this fact, however, the war is used by many as an excuse to devote even less time to the technical literature than the few hours which heretofore were allotted begrudgingly for this purpose.

Embarking upon an important and expensive research program without first making an adequate survey of the technical literature is a disadvantage that appears to be recognized by too few directors of research. Statistics of the Patent Office indicate that at least 30 percent of the patent applications filed are abandoned, the great majority because they disclose nothing patentable over the technical literature. This involves a loss of millions of dollars annually, but it still continues. Furthermore, it is likely that an even larger number of patent applications issue with patent protection so emasculated that they have, at most, a nuisance value. Many of these abandoned and emasculated patent applications are supported by research programs as extensive and expensive as the small minority of important and valid patents which are issued.

Public opinion to the contrary notwithstanding, VALID patents have not joined the dinosaur as extinct curiosities. If these research programs had been based upon an adequate search of the literature they would not have ended by rediscovering what was already described in this literature. They would have been devoted to virgin fields wherein the inquisitive gaze of the scientist is sadly needed. In these fields the same time and money would have produced inventions upon which valid patent protection of genuine value could have been obtained. These inventions would not only have been of great importance to humanity but the patent protection which could have been obtained thereon would defray the expense of further research by the organization in question.

(Editor's Note: An executive of a leading textile organization comments: "We have emphasized the necessity of searching the technical literature in our Corporation, and although we do not believe in discouraging the research worker by having him make the search, we do believe it should be made and the results provided for the consideration of the one who is to decide whether a project should be undertaken.")

* From a paper by A. G. Connolly entitled "Library versus Laboratory Research," presented at the Pittsburgh Meeting of the American Chemical Society.

Cloth Handling in the Finishing Plant Is Compared With

The Dynamics of Flowing Cords

By R. W. VOSE

A Contribution of the Research Division, Chicopee Mfg. Corp.

The behavior of fast-running cords is analyzed, with particular reference to the behavior of ropes of cloth encountered in a textile finishing plant. Theoretical formulas are deduced whereby the behavior at any point may be calculated, and from them practical deductions are drawn for direct use by the engineer.

Throughout the textile finishing industry it is common to transport cloth from process to process, and also through some of the processes, in either rope form or open width form. With increasing demands for high production and with improvements in processes and machinery have come successive increases in the speeds with which cloth is transported in these forms, and it has been found that the upper limits of speed are in general determined by the dynamic behavior of the cloth. It is not generally realized that some of these dynamic considerations cannot be controlled by mechanical design, and that they therefore impose an absolute limit on performance which no amount of refinement can be expected to overcome.

The technical literature on flowing cords is very meager, being confined almost exclusively to the treatment of power transmission belts.[1] In this latter field practical considerations dictate that extremely high speeds should be avoided, and hence dynamic considerations have received only passing notice. Fortunately, it is possible to treat belting, cloth in rope form, and cloth in open width form, in a single class under the general designation of a "cord." To do this, it is necessary to assume that the material is relatively flexible in proportion to its weight so that stiffness effects can be neglected, and to assume that a cloth rope travels over a guiding surface as a unit without "bunching" or "cutting" over relatively sharp corners or guiding surfaces. Under these conditions equations governing the dynamic behavior of the cord may be derived on the basis of fundamental principles of mechanics. In certain cases the equations are the same as those encountered in transmission belting practice, and such equations are given below with only a suggestion as to their derivation. On the other hand, some of the equations are entirely new and sufficient derivation is given so that those who are mathematically inclined may verify them.

(*Continued on next page*)

[1] Marks' Mechanical Engineers' Handbook and Timoshenko & Young's "Engineering Mechanics—Dynamics" are suggested for reference.

Although much of the material given below is of a mathematical nature, the results are nevertheless intended to be of direct application in the design of cloth handling apparatus. The equations cover every form of flowing cord, such as ropes, belts, band saws, and even anchor chains, but there are certain of them which are of particular importance in textile finishing plant work. Therefore, for the sake of convenience the more directly usable results have been summarized for the benefit of those who do not wish to follow the detailed mathematics. The summary is given in qualitative terms for use where calculations are not necessary:

1. A certain critical tension exists in a cord being pulled off a pile, even if the cord runs freely without tangling and friction. This tension must be supplied by appropriate mechanical means in order to secure the desired speed.

2. In passage around a guide, over pulleys, or around hauling drums, only the angle of wrap and coefficient of friction are of significance. Unless the radius of curvature is unduly small it does not in any way affect the friction present or "traction" available.

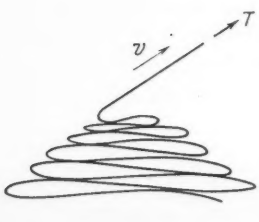
3. Through centrifugal force the pressure against any drum or guide is relieved at high speeds, and becomes zero at the critical speed so that control is lost.

4. On the delivery end of a cord being piled the tension is determined solely by the height of drop. If this tension is less than the critical the cord will throw so that it will not fall vertically and in addition will leave the surface of any hauling drum so that traction will be lost. The theoretical upper limits of speed for different heights of drop are given in the table on page 112. The practical speeds must be a safe margin below the tabulated values, but only trials can show the proper figure in each case.

Notation

C, D = constants of integration
e = base of natural logarithms, 2.718+
F = force of application of press roll
f = coefficient of friction
g = acceleration of gravity
h = height of a point
h_0 = initial height
P = pressure against cord, in terms of force per unit length
r = radius
T = tension in cord
T_0 = initial tension
T_c = critical tension
v = speed of cord
x = horizontal coordinate
θ = angle (in general) or angle of wrap of cord on an object
ρ = weight per unit length of cord

Case I—Cord Pulled Off Pile

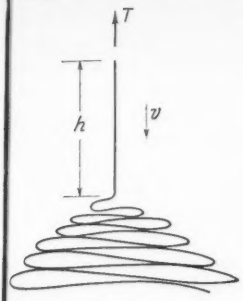


In the case of a cord continuously being pulled away from a loose pile the tension required may be obtained by equating impulse to change in momentum:

$$T = \frac{(\rho v)v}{g} \text{ (for unit time)} \quad \text{or} \quad T = \frac{v^2\rho}{g}$$

It will be noted that this tension is twice that required to give the cord the kinetic energy accom-

panying its speed v. It will be found on close study that the excess energy is dissipated in lateral vibration, but this is not a part of the present problem.



Case II—Cord Being Piled

In the case of a cord being piled by the ordinary process of being dropped over a drum, the tension is due solely to the weight of the cord hanging below any given point. The tension is therefore:

$$T = \rho h$$

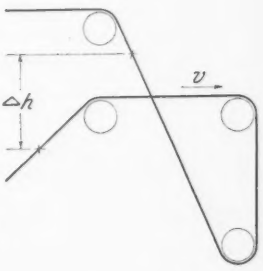
where h is the distance above the pile.

Case III—Effect of Height

As a cord passes from one point to another at a different elevation its tension is changed due to the extra weight of cord hanging from the point at higher elevation. Numerically this may be determined from the equation of the catenary as follows:

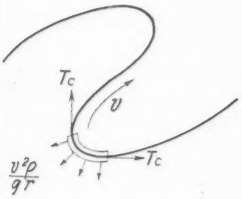
$$T = \rho(h - h_0) + \text{const.}$$

$$\text{from which } \Delta T = \rho \Delta h$$



It will thus be seen that regardless of the angle to the horizontal at which the cord travels any change in tension due to gravitational effect is due solely to change in elevation. Further, provided the cord meets no friction of any sort, it does not matter what type of path is traversed between any two given points. Thus if free running pulleys are used any number of horizontal runs, vertical climbs, or angular climbs may be encountered without changing the differences in tension between two fixed points. It will be recognized that this law is analogous to that of hydraulic pressure where pressure differences are solely a function of elevation.

Case IV—Critical Tension of a Flowing Cord



It is a common experience that under certain conditions a curve or even a loop may be inserted in a rapidly running cord and that the curve or loop will remain in stable equilibrium for a considerable length of time. This situation occurs in very slack transmission belts, in the operating chain of the common geared chain fall, in other freely traveling cords, and is approached in certain cases in the finishing plant. The explanation of the behavior lies in the fact that the outward centrifugal force of the moving cord passing through a curved path may exactly balance the inward force due to the curved path of the tension in the cord. The following is the equation, neglecting gravitational effects:

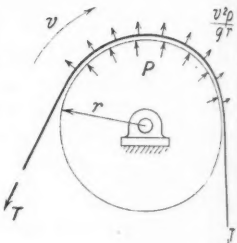
$$\frac{T_c}{r} = \frac{v^2\rho}{rg} \quad \text{or} \quad T_c = \frac{v^2\rho}{g}$$

It will be found that at tensions above the critical the cord will run straight in

a perfectly uniform and normal way, that at the critical tension any curve which is placed in the cord will remain there, and that below the critical tension loops and bends will be immediately created until slack is taken up and the tension has reached the critical value. This phenomenon is often seen in boat yards where the "snaking" of a loose rope running on the ground is a graphic and often dangerous demonstration of the principle. As a matter of interest, it should be noted that the critical tension is identical with the tension of a cord pulled off a pile, Case I.

Case V—Cord Guided by Idle Pulley

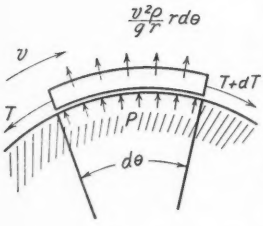
Where a cord passes over an idle pulley, without friction and without applied power, the only action is through the bearing of the cord on the face of the pulley. The pressure against the pulley face is a function of the tension in the cord and of the radius of the pulley, but it is relieved by centrifugal force according to the following equation:



$$P = \frac{1}{r}\left(T - \frac{v^2\rho}{g}\right)$$

It will be noticed that the pressure against the pulley face reaches zero when $T = \frac{v^2\rho}{g}$, or in other words when the tension is reduced to the critical tension for the speed at which the cord in running. The cord can then leave the pulley face and run without guidance, as is to be expected under critical conditions.

Case VI—Drag Over Fixed Guide



In passing over any sort of a fixed guide the tension in a cord is increased in proportion to the tightness with which the cord presses against the guide, the coefficient of friction, and the angle of wrap around the guide. This assumes, as has previously been stated, that the guide has no sharp corners which actually cut or otherwise disturb the smooth running of the cord. The equation is similar to one which is encountered in transmission belting, although commonly the term due to centrifugal force of the moving cord is neglected.

The pressure against the guide at any point may be determined as in Case V:

$$P = \frac{1}{r}\left(T - \frac{v^2\rho}{g}\right)$$

for an element of length the change in tension is the product of the pressure, the length, and the coefficient of friction:

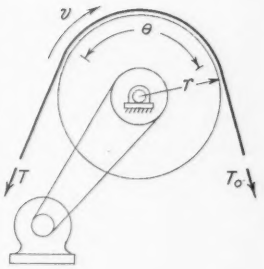
$$dT = \frac{1}{r}\left(T - \frac{v^2\rho}{g}\right) f r d\theta$$

which gives on integration:

$$T = \left(T_0 - \frac{v^2\rho}{g} \right) e^{f\theta} + \frac{v^2\rho}{g}$$

It will be seen that with small coefficients of friction or small angles of wrap the initial tension T_0 in the cord is but very little magnified, and that the radius of the guide has no effect. Likewise, at high speeds the term $\frac{v^2\rho}{g}$ approaches T_0 with decreased pressure and correspondingly smaller magnification. At the critical speed, where $T_0 = \frac{v^2\rho}{g}$, the cord entirely leaves the guide and traverses the change in direction without frictional effects.

Case VII—Hauling Drum



The situation on a drum to which power is applied, or to which a brake is applied, is practically the same as the case of a fixed guide except that the friction is static instead of dynamic, and the change in tension may be controlled at will up to a maximum value. While there is without question a difference between the two coefficients of friction, it is probable that in practice this difference is negligible compared with other variables in the operation. In any event the proper coefficient of friction should be used, and the equation for maximum tension is the same as given for Case VI:

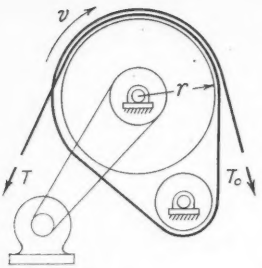
$$T = \left(T_0 - \frac{v^2\rho}{g} \right) e^{f\theta} + \frac{v^2\rho}{g}$$

It should be noticed that whereas with a fixed guide or with a braked drum the retreating end of the cord is under heavier tension than the approaching end, the reverse is true if power is applied to the drum in order to move the cord. It will be further noted that the radius of the drum does not appear in the equation, and this brings out that there is no advantage in using large drums to gain "traction." As long as the drum is not so small that it actually cuts into the cord or seriously deforms it, only the angle of wrap and the coefficient of friction are of interest.

The calculations are set up to give the maximum tension which can be developed at the point where the cord begins to slip on the drum. In practice it is highly inadvisable to attempt to utilize this full effect since any slight change in conditions might bring about slippage and burn the cord. Therefore it is good practice to limit the power, or the braking, applied to the drum to perhaps half the value needed to give the theoretical maximum tension.

Case VIII—Hauling Drum With Multiple Turns

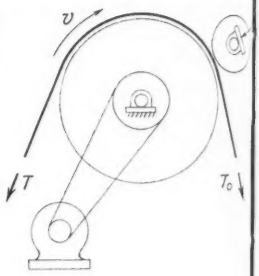
It is common practice to obtain high "traction" on a cord by taking a wrap on a drum through an angle of 2π or more. In order to do this without tangling it is usually necessary to offset one turn from another on the drum by means of a



fixed guide or by means of a skewed roll. It is obvious that a fixed guide retards the cord according to Case VI and decreases the tension available for pulling purposes, and therefore if its use is unavoidable it should be placed nearest to the slack end of the cord where the pressure on it will be the least. With a skewed roller turning freely the location becomes a matter of mechanical convenience only since no retarding effect occurs. In either case some angle of wrap is lost on the driving drum, but this may be minimized by making the guide or the skewed roll relatively small and locating it close to the drum.

Calculations of the tension available through this arrangement may be made by applications of the equations of Cases VI and VII, treating each section successively and commencing from the slack end of the cord.

Case IX—Hauling Drum with Press Roll



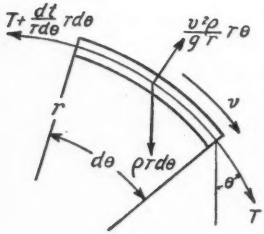
The tractive effort of a hauling drum may be increased by use of a press roll which forces the cord against the drum. If the press roll is set up to exert a force F against the drum the increased tension possible at the point of contact is:

$$\Delta T = Ff$$

This increase in tension should be obtained near the slack end of the cord so that it may be magnified in its subsequent passage around the circumference of the drum. In this case the resulting available tension in the cord is:

$$T = \left(T_0 + Ff - \frac{v^2\rho}{g} \right) e^{f\theta} + \frac{v^2\rho}{g}$$

Case X—Cord Piled by Throwing



In certain types of kier pilers a cloth rope is run at high speed and projected at an angle to the vertical so that its landing point is not directly below the piling apparatus. By controlling the angle and direction of projection it is possible to pile the cloth uniformly over a considerable area. The requisite condition for this type of piling is that the tension due to the height of drop, $T = \rho h$, shall be less than the critical tension for the speed of operation. It will be recognized that under these conditions the cord no longer traverses a straight path and may be made to take a curve, in this case controlled and defined by gravity.

Analysis of the path taken by the projected cord may be made by considering an elemental length of cord flowing in its downwardly curved path. Acting on this length will be tension on its lower end, tension on its upper end, centrifugal

force acting outwardly with respect to the curvature of its path, and gravity acting downwardly. The lower end of the element may be taken to have an angle θ with respect to the vertical and a tension T acting on it. The upper end will then have an angle $\theta + d\theta$ and a tension $T + dT$, both θ and T changing along the cord. The centrifugal force acting outward is $\frac{\rho v^2}{gr}$ per unit length, and the gravitational effect is ρ per unit length acting vertically downward. By taking equilibrium equations of the components of these forces both parallel and perpendicular to the path of the cord a complete analysis may be made, as follows:
Equilibrium parallel to path:

$$T + \rho r d\theta \cos\theta = T + \frac{dt}{r d\theta} r d\theta$$

$$dt = \rho r d\theta \cos\theta = \rho dh$$

which gives on integration:

$$T = \rho h$$

as in cases previously considered.

Equilibrium perpendicular to path in plane of curvature:

$$\frac{\rho}{g}\frac{v^2}{r} r d\theta = \rho r d\theta \sin\theta + 2T\frac{d\theta}{2}$$

substituting $T = \rho h$ and simplifying:

$$\frac{v^2}{g} = r \sin\theta + h$$

expressing r in terms of θ, $d\theta$, and dh, and integrating

$$\sin\theta = \frac{C}{\frac{v^2}{g} - h}$$

expressing the horizontal projection of the path in terms of h and θ:

$$dx = \frac{Cdh}{\sqrt{\left(\frac{v^2}{g} - h\right)^2 - C^2}}$$

which gives on integration:

$$x = C \cosh^{-1}\left(\frac{\frac{v^2}{g} - h}{C}\right) - D$$

setting $h = h_1$, $\theta = \theta_1$, and $x = 0$ at the point of leaving the piler, the constants C and D may be determined, leading to the final equations:

$$\sin\theta = \frac{\frac{v^2}{g} - h_1}{\frac{v^2}{g} - h} \sin\theta_1$$

(*Continued on next page*)

$$x_0 = \left(\frac{v^2}{g} - h_1\right) \sin\theta_1 \left[\cosh^{-1}\left(\frac{\csc\theta_1}{1 - \frac{gh_1}{v^2}}\right) - \cosh^{-1}(\csc\theta_1)\right]$$

where x_0 is the horizontal coordinate of the lower end of the path, i.e., the total throw. It will be noted that x_0 becomes zero and θ becomes zero if $\frac{v^2}{g}$ drops to h_1. It is therefore necessary for the success of this action that the cord actually issue from the piling device with a speed which is definitely above the critical, otherwise the cord will merely drop vertically.

On consideration it will be seen that even a slow running cord being dropped vertically onto a pile will pass through a region where the tension is less than the critical. This occurs as the top of the pile is neared. In this region if the cord is disturbed it will run in a curved path, but since gravity is present there is a tendency for the cord to resume its vertical path. The action required to maintain the curved path may be comaratively small, however, so that light prodding with a stick held in the hand may suffice to throw the cord for a considerable distance. This is a common way of piling a kier.

If a throwing type of piler is fed from an overhead hauling drum it will be recognized that the tension at the drum must be above the critical and at the piler must be below the critical for proper operation of each device. The tension at these two points can be made to differ only by reason of vertical height, and consequently an appreciable drop from the drum to the piler is necessary in order to provide a safe operating margin for each.

Table I.—Critical speeds for various drops

$$\frac{v^2}{g} = h$$

Drop (meters)	Speed (meters/second)
.1	1.0
.5	2.2
1	3.1
2	4.4
5	7.0
10	9.8

If it is desired to throw a cord, as in a throwing type of kier piler, the speed must be higher than the critical speed given in the foregoing table in order that the cord shall throw freely and not merely fall vertically.

Acknowledgment

The author wishes to acknowledge the support and encouragement of Mr. N. L. Smith and Mr. John F. Shaw, respectively President and Vice President of the Chicopee Manufacturing Corporation, the practical advice of the staff of the Chicopee Finishing Plant, and the assistance of various members of the staff of the Chicopee Research Division.

RESEARCH AIDS

Cellulose and Cellulose Derivatives*

(Review by Wanda K. Farr)

In this fifth volume of a series concerning High Polymers issued by Interscience Publishers, Inc., thirty-six authors have prepared "a present day picture" of the nature of cellulose and cellulose derivatives. The following quotations taken at random from the text will enable the reader to appreciate the scope and importance of the treatise:

(Page 3) "To summarize, this book attempts to follow cellulose from its vegetable sources through the laboratory research, which has determined its properties, into the industrial problems such as isolation and purification derivative formation and technical applications."

(Page 427) "The primary photosynthetic product of green plants is probably a hexose sugar, either glucose or fructose, and the former appears as the building unit of the two polysaccharides that have major roles in the plant, namely cellulose as a structural unit and starch as a reserve. However, other polysaccharides associated with cellulose in the cell wall or present like starch in the cell may contain and indeed are often exclusively composed of sugar units other than glucose."

(Page 44) "The physical properties of fibrous cellulose and of its solutions has created a deep seated feeling that the polysaccharide was essentially a colloid. Unfortunately, for the study of cellulose and other high polymers, most of the spectacular early success of colloid chemistry did not concern linear macromolecules, but were obtained with atoms or small molecules which assembled in regular array to form aggregates of colloidal size.—These systems resembled solutions of cellulose and its derivatives in the unexpectedly minute values they displayed in osmotic pressure and similar determinations, in their abnormal viscosity phenomena, and in the erratic and apparently capricious way the quantitative data depended upon the previous history of the specimen and on the experimental details."

(Page 43) "Much of the doubt surrounding the structure of cellulose was swept away at one stroke when almost completely methylated cotton was degraded in very good yield to the well-characterized, crystalline 2, 3, 6-trimethyl glucose. This result demonstrated that hydroxyl groups occupied the second, third, and sixth positions of each glucose residue in cellulose.—The adoption of the pyrone ring structure for the more stable type of glucosides, together with the demonstration that cellulose was a 4-glucopyranosyl-glucose, then made it reasonable to regard cellulose as a linear molecule in which uniform and equivalent, main valence glucosidic links unite a large number of hexose units (Structure VII). This view is almost universally accepted today and all other sections of this text are devoted to expounding it."

(Page 203) "The first field of x-ray

analysis as applied to cellulosic material is in the interpretation of the sterochemistry of the cellulose molecule.—The second field—is in the interpretation of the form, arrangement, relative amount, and properties of the cellulose crystallites and their relation to the intercrystalline material. This dual structure built up of crystalline and intercrystalline material will be referred to as 'fiber' structure."

Within these, and other more general conceptions of the nature of cellulosic materials, are woven the data relating to Cellulose Tests; Degradation of Cellulose; Microscopic Investigation; Mercerization; Beating and Hydration; Sorption of Water and other Vapors; Hemicelluloses; Lignin and other Non-Carbohydrates; Wood Pulp; Cotton Linters; Bast Fibers; Straw, Grasses, and Similar Materials; Bleaching and Purification; Chlorination; Kinetics and equilibria involved in Cellulose Reactions; Inorganic Esters; Cellulose Organic Acid Esters; Xanthates; Cellulose Ethers; Solubility; Thermodynamic Properties; Molecular Weight; Viscosity; Elasticity and Strength; and Technical Applications of the Physical Properties of Cellulose and Cellulose Derivatives; to make up the heterogenous subject matter of 1176 pages.

(Page 2) "It is the opinion of the editor that the picture of cellulose as a system of long chains of anhydroglucose units is the most important concept in the book."

* CELLULOSE AND CELLULOSE DERIVATIVES. *Interscience Publishers, Inc., 215 Fourth Ave., New York, N. Y. 1176 pp. Price $15.00.*

Index to A.S.T.M. Standards*

The annual index just issued by the American Society for Testing Materials lists the 738 A.S.T.M. Standards and 431 Tentative Standards in effect as of December 1943, under appropriate key words. Also included is a list of the standards in numerical sequence of A.S.T.M. Serial Designations which gives the complete title and publication reference of each standard.

This index comprises a ready reference for locating any A.S.T.M. standard in the bound publication of the Society in which it appears. The index should also be of service in ascertaining whether the Society has issued a standard on a specific subject.

* American Society for Testing Materials, 260 S. Broad St., Philadelphia, Pa.

Cotton from Raw Material to Finished Product*

Included in the third edition of "Cotton from Raw Material to Finished Product" recently issued by the Cotton-Textile Institute, Inc., are 94 swatches of basic cotton weaves. They include samples of print cloth yarn fabrics, gray and finished; narrow sheetings and allied fabrics; combed and fine carded goods; colored yarn and napped cloths; industrial fabrics and specialities; household cottons; upholstery and drapery fabrics; pile fabrics; and washable wall coverings.

Subjects dealt with at considerable length comprise the history of the industry, the qualities and characteristics of raw cotton fiber, the spinning, weaving and finishing of cotton cloth, the variety of products produced by cotton

mills together with a list of major uses of each staple fabric.

The book also includes fifteen statistical tables covering the growth, production and distribution of cotton and cotton goods, the distribution of machinery and the financial history of the industry.

This book has a wide interest especially for persons whose interest in the industry is necessarily broader than that of the student and less exacting than that of the scientist and technician. That it has served its purpose so far is attested by the fact that about five thousand copies have been sold over the last four years.

* Cotton from Raw Material to Finished Product, The Cotton-Textile Institute, Inc., 320 Broadway, New York 7, N. Y. Price $1.20.

The Fibrograph is Available

Textile men will be interested in the announcement that the Fibrograph, developed at the University of Tennessee, is now available in limited quantities, for delivery from three to six months after receipt of order.

Fig. 1. Fibrograph.

The fibrograph is an optical instrument employing photovoltaic cells for scanning samples of parallel fibers and simultaneously tracing a length-frequency curve. The geometrical properties of the resulting curve, or fibrogram, make it possible quickly to obtain average lengths of various kinds, variance, coefficients of variation, and other statistical measurements. The time for a complete length analysis is 6 to 7 min. The waviness and taper of the fibers are factors that make the fibers appear too short. The upper-half mean length, however, agrees closely with the staple length. Fibers shorter than ¼ in. are disregarded.

Inquiries should be sent to the manufacturer, The Fulton Sylphon Co., Knoxville 4, Tennessee.

Year Book of the A.A.T.C.C.*

The 1943 Year Book of the American Association of Textile Chemists has been distributed to members. The organization of the Association is given, listing the officers and committee personnel of the various sections together with a complete list of members. A section is devoted also to reports of committees of which the report of the Research Committee and the Committee on Color, both of which include a comprehensive bibliographical reference list, will be of special interest. Another section gives in detail both the official and tentative standard test methods devised by the Association. Also included is a classified listing of American-made dyes arranged both alphabetically and by color index numbers.

* Published for the Association by Howes Pub. Co., Inc. 440 Fourth Ave., New York 16, N. Y.

The Textile Industry Has Found Important Applications for

Alkyd Resins in Textile Finishes

By GEORGIA LEFFINGWELL, Ph.D.

Originally developed for paints, varnishes, lacquers and other protective coatings to impart durability, toughness, resistance and other desirable qualities, the possibilities of alkyd resins for textile applications were soon recognized by the textile industry. The first of the alkyd resins was placed on the market less than twenty years ago, and by 1930, patents had already been granted for their use to impart special qualities to textile materials [1].[1] In India, in 1942, Sarkar [2] comments that alkyds are finding more and more use in the textile industry. The technical and patent literature bear this out quite definitely [3, 4, 5].

It may be said, without discussing in detail the complex chemistry of these modern synthetics, that the alkyd group of resins are produced by reacting polyhydric alcohols, glycerine being the most frequently used, with polybasic organic acids, such as phthalic, maleic, succinic, and sebacic. Of these resins, those designated as glycerine-phthalate (or glyceryl-phthalate) resins are generally the most widely employed. Although straight alkyds have found some few uses, the condensation product is almost always modified to give to the resin properties essential to the specific action contemplated. Such a modifying agent may be a drying, semi-drying, or non-drying oil; the fatty acid of an oil; a natural resin; a synthetic resin of the tar-acid group or of the urea-formaldehyde type; or other substance.

Practically endless modifications are possible and by the selection of proper starting materials, by changes in procedure and by the selection of suitable modifying agents the resin chemist is able to meet an almost infinite number of specific needs.

Alkyd resins are available under a variety of trade names, of which the following are among the most important: Beckosol, Dulux, Esterol, Glyptal, Rezyl, and Teglac [6]. Each of these trade names identifies a series of products and although not all are applicable to textile finishes, the majority of large suppliers also produce materials specifically intended for fabric treatments.

General Properties

Alkyd resins vary considerably among themselves. Cleaveland [7], however, has recently made a compilation of the general properties which make the alkyds increasingly useful in textile processing and more especially in textile coatings. A tabulation of these properties is given in TEXTILE RESEARCH, p. 72, March, 1944.

The increase in the popularity of the resin finishes, it was pointed out in

[1] Figures in brackets indicate the literature references at the end of this paper.

1937, by Powers [8] was due to factors such as: (1) production of permanent effects and fabric improvements not obtainable in other ways, (2) greater ease and simplicity of resin application, (3) greater range of effects possible from a wider range of resins, (4) increase in the use of spun rayon needing a permanent resin finish, (5) increasing consumer demands for permanent finishes, and (6) development of resin finishes which proved popular and profitable. Any fiber, silk, wool, cotton, or rayon, he noted, may be treated with one of a number of clear colorless resins to build up the fabric from one to 20 per cent. The resins are made into a wash-fast insoluble form to give the fabric increased resilience, luster or glaze, strength, water repellency, fullness, firmness, or durability. Among resins suitable for general application, Powers lists glycerine-phthalic anhydride condensates.

For textile finishing according to Roberts [9], the alkyd resins are used either alone or to modify or plasticize resins in other groups. They are often used for this purpose in the production of emulsions for printing and finishing. "As an adhesive and binding material," Roberts reports, "the alkyds have shown a great deal of promise. We have recently seen the widespread use of a series of resins of the alkyd type, marketed in the form of aqueous solutions in some cases, while in others, they have been put out in the form of emulsions. In back filled work and for non-slip finishes on rayons, they are rendering excellent service."

Aqeous Solutions

Use of glycerine-phthalate condensates in aqueous solution for textile treatments is not new. It was the subject of a British patent [1] granted in 1930. According to the process described, cotton and rayon may be given a woolen feel or othewise modified by treatment with an aqueous solution of a specified alkyd resin, which is then fixed by treatment with an acid or with metal salts.

Combined with other types of synthetic resins, alkyds are frequently employed to impart special desirable finishes on fabrics. The resinous combinations may be applied from organic solvents or in the form of aqueous dispersions. Examples of the latter are available in processes developed by the Imperial Chemical Industries for making fabrics transparent and impermeable to fluids, and at the same time increasing their gloss [10]. In reporting on these developments, Tupholme [11] stated that the process consists in impregnating the fabric with nondrying oil or semi-drying oil-modified polyhydric alcohol-polybasic acid (alkyd) resins in conjunction with urea-formaldehyde condensation products. It is stated that the process eliminates discoloration and tackiness when the fabrics are subjected to heat treatment for short periods of time. The procedure is also said to impart excellent flexibility, soft handle, freedom from cracking or powdering, and from objectionable tendering.

Examples of such treatment are described by Tupholme. Thus, silk and rayon are treated by immersion in a solution of the synthetic resinous composition in an organic solvent which is volatilized at 70° to 80° C. and then subjecting the fabric to further heat treatment. Suitable plasticizers, such as dibutyl phthalate or tricresyl phos-

phate, are often desirable when fabrics are treated with such resins. The alkyd resins used are glyceryl phthalate resins modified with one of several oils, but the one generally employed is a castor oil-modified glyceryl phthalate resin. Dyed or printed fabrics as well as undyed material may be treated by this process. If desired, solvent soluble dyes may be added to the synthetic resin solutions. Light silks and rayons are usually processed with an amount of solution which results in an increase in weight of from 50 to 200 per cent. On cottons the increase is much greater—from 200 to 500 per cent.

A series of patents covering the use of aqueous suspensions of synthetic resins, usually urea-formaldehyde resins, plasticized with an alkyd resin has been secured by one of the large resin manufacturers [12, 13]. The alkyd usually specified is a non-drying glycerine-sebacic acid resin. In one method [14] for finishing textiles, an aqueous dispersion of a synthetic hard-enable resinous material is mixed with an aqueous suspension of a non-hard-enable alkyd resin and sufficient water to make the total resin content of the mixture less than 5 per cent by weight. The textile is padded through this mixture and then dried.

Emulsions

Use of alkyd emulsions is evident by the technical literature. Gurley [15] mentions that wash-resistant glaze finishes can be produced on fabrics by coating with an emulsion of alkyd resins. An alkyd resin is an important component in a patented procedure for making glazed chintz fabric [16]. In another instance, a finish similar to that produced by starch is obtained by applying an aqueous emulsion of an alkyd resin modified by incorporating benzoic acid or an alkyl-substituted benzoic acid [17]. In Europe, glycitric resins, combinations of glycerine and citric acid, have been suggested as water-soluble agents for use in treating and finishing textiles [18].

Specialty Finishes

SOLUTIONS OF ALKYD RESINS IN ORGANIC SOLVENTS have long been a standard means of applying these materials in textile processing. In an example of such usage, an alkyd is an important component of a waterproofing lacquer suitable for use on silk fabrics. The lacquer used for this purpose is formed of ingredients such as cellulose nitrate, butyl acetylricinoleate, a glycerine-sebacic acid resin, a solvent and comminuted mica [19].

INDUSTRIAL AND OTHER USES employ the advantageous properties inherent in alkyd resins. An example is the insulating varnished cambric now used chiefly for wrapping Navy cables, which has long been a standard application for alkyd resins. Improvements in such insulating materials continue to employ these resins. A recent patent [20] describes a new method for making electrical insulating materials by treating fabric with a glycerine-phthalic anhydride-maleic anhydride resin modified with cottonseed stearin. The finished product is said to be flexible, odorless, heat-resistant and age-resistant.

COATED FABRICS FOR FUEL PUMP DIAPHRAGMS are also improved by the use of special alkyd resins. Thus a flexible fabric of this type is imperviously coated with a resinous product formed from glycerine with sebacic acid and citric acid. From 5 to 20 per

cent of lampblack is incorporated to prevent solubility and scuffing off of the coating [21, 22].

SPECIAL FINISHING PROCESSES in which the alkyds are employed to impart specific qualities to fabrics should also be mentioned. For example, in a snag-proofing treatment of synthetic linear polymer yarns, a method is employed for producing sheer knit goods, substantially free from snags and pulled threads, by applying a resinous film to the yarn. In making this snag-proofing composition use is made of a castor oil-modified glycerine-phthalic anhydride resin [23].

NONDRYING OIL-MODIFIED ALKYD RESINS, such as castor oil-modified polyesters of sebacic acid and phthalic anhydride-glycerine resins form an important component part of coatings used to make transparent cotton netting suitable for exposure to the elements [24]. The value of alkyd resins in coatings is further exemplified by its use in varnishes over rubber, applied to fabrics as a protective finish [25]. In this instance the resin base for the varnish is specified as a glycerine-phthalic anhydride condensation product.

FOR TREATING FABRICS OF REGENERATED CELLULOSE, soybean oil-modified glyceryl phthalate resin dissolved in xylene is mixed with a much smaller proportion of a solution of urea-formaldehyde resin dissolved in a mixture of toluene and butyl alcohol. The fabric is then dried and the increase in weight is 200 per cent [11].

War-born Uses

The war is directly responsible for many new applications, some of which cannot be discussed at this time, but others have already become well accepted and are generally known. Thus it is recognized that these useful resins are finding important application in producing gas-resistant fabrics that are useful in chemical warfare [7].

Replacing the scarce oiled silk which is needed to cover bandages over wounds, has led to another war-born use for alkyd resins. Recently oiled artificial silk, made impervious by the use of an alkyd resin, has been made official in the *British Pharmaceutical Codex* [26]. This is officially described as follows: "Oil artificial silk consists of rayon fabric woven from a 30-denier strong rayon yarn of 70 or more filaments and having not less than 100 threads in the warp and in the weft, completely water-proofed by treatment with a plasticized synthetic resin of the type known in commerce as 'glyptal,' and without adding colouring matter."

Printing and Dyeing

In printing and dyeing processes there is a growing tendency, as evidenced in the patent literature [27, 28, 29, 30], to employ alkyd resins, alone or in combination with other synthetic resins. Both aqueous dispersions and organic volatile solvent solutions are employed in these methods. An interesting process for coloring textile fabrics has been developed by Kienle and Peiker [31, 32]. In their methods, a coloring substance is incorporated in a dispersion of long-oil alkyd resin having water as the continuous phase. In an example given in one of their patents a mixture of 2 parts of Ultramarine Blue, 1 part of Indanthrene Blue B.C.S. (C.I. 1114) and 0.53 part copper phthalocyanine is used with 100 parts of an emulsion composed of al-

kaline casein solution 66.6 parts, and oxidizing type alkyd resin 16.6 parts, a butanol solution of dimethylolurea (60% resin) 8.4 parts, and dimethylolurea resin 8.4 parts. This was ground, printed on cellulose fabrics and cured for 5 minutes at 150° C. Prints fast to washing soaps, alkali and chlorine, light and cellulose acetate solvents were obtained by this procedure.

In flock printing processes alkyds may also be used. According to one process [33], flock is applied to a textile coating in a predetermined design with an adhesive comprising a permanently flexible, oil-modified alkyd resin of the heat convertible, non-airdrying type dispersed with a volatile dispersion medium such as petroleum naphtha. The flock-coated textile is then heated to eliminate the dispersion medium and heat-set the resin.

Alkyd resins are also employed in impregnants and coatings for supports used in dyeing or other fluid treatments of yarn in package form [34].

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ABSTRACTS

Members of Textile Research Institute, Inc., desiring complete copies of articles abstracted may obtain photostat copies at cost by addressing the Institute's office, 10 East 40 St., New York 16, N. Y. The price of a photostat negative is seldom more than 30 cents per page of original text.

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A list of periodicals and the abbreviations used appeared on page 32 of the January, 1944 issue of TEXTILE RESEARCH.

ANALYSIS: TESTING LABORATORY METHODS

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Acetyl Determination

The determination of the acetic acid yield of acetylated celluloses. Frank Howlett and Elizabeth Martin. *J. Text. Inst.* **35**, T 1–6 (Jan. 1944).

The method described provides for hydrolysis with aqueous alkali in the presence of NaCl, which minimizes swelling; addition of an excess of standard acid and back-titrating the excess acid. In the case of triacetates or other samples difficult to wet and to hydrolyse, KOH in 50% alcohol is employed to effect hydrolysis. In the case of dyed samples where the dye would interfere with the endpoint, carbon tetrachloride is added to absorb the color from the aqueous phase.

Gas Permeability of Films

Apparatus for measuring gas transmission through sheets and films. H. Russell Todd. *Paper Trade Journal* **118**, 32–35 (Mar. 1944).

A simple volumetric apparatus for measuring the transmission of gases through sheets and films is described. The sensitivity of the apparatus is shown to be approximately 0.019 cc per 100 sq. in. per 24 hours for a 24-hour period. The permeability of ethyl cellulose to air was found to vary with temperature and humidity conditions. In dry air the transmission rate at 36.7° C. was more than double the rate at 1° C. Humidity had the effect of decreasing air transmission through ethyl cellulose, whereas it markedly increased the transmission rate through regenerated cellulose.

Measurement of Fibers

Projection arrangement for determination of fiber dimensions. John H. Graff and John R. Feavel. *Paper Trade J.* **118**, 140–45 (Feb. 17, 1944).

The methods used for the determination of fiber dimensions are either too inaccurate or too time consuming, and they give little consideration to the relative width of the fibers and to the relative percentages of whole and broken fibers, ray cells, and fiber fragments. The present paper describes a projection arrangement by means of which the length and width of the fibers can be determined and the necessary calculations made in a fraction of the time used for direct microscopic measurements. The relative percentages and frequency distribution of whole and broken fibers, ray cells, and fiber fragments can easily be calculated from these data.

Mildew Resistance

Observations on soil burial procedures. E. C. Bertolet. *Am. Dyestuff Reptr.* **33**, 21–4 (Jan. 3, 1944).

The laboratory accelerated mildew (mold) test as a measure of expected service life of fabrics used in sandbag construction has been abandoned by the Corps of Engineers because it does not distinguish between weather-resistant and non-weather-resistant finishes. A modification of the tentative ASTM soil burial test method has been adopted by the Jeffersonville Quartermaster Depot as more nearly approaching the testing requirements of the tentage and personal equipage procured by them. Twelve samples cut fillingwise are completely buried 14 days at 75° F. ± 5°. Complete details of the test method are

given. It is admitted that the deteriorating effect of ultra-violet radiation is a factor in service-life which is excluded in the soil burial test, but artificial sources of ultra-violet are believed too severe. Burial tests are frequently run following various periods of exposure to outdoor weathering. The pH, moisture and temperature of soil used are very important.

Testing Synthetics

The testing of rayon and synthetic yarns. Part I. Anon. *Silk J. Rayon W.* **20**, 27–28 (Oct. 1943).

This series of articles is intended to explain the nature of the tests, the type of apparatus required, and the testing technique for the identification and tensile properties of rayon and synthetic materials. They will be of particular interest to those who, accustomed to dealing with the usual and natural fibers, such as cotton and wool, find the synthetic materials entering more and more into their sphere of business. Part I deals with a general classification of the rayon and synthetic fibers and yarns.

CHEMICAL AND PHYSICAL RESEARCH

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Polyhydric Alcohol Esters

Polyhydric alcohol esters of fatty acids. Their preparation, properties, and uses. H. A. Goldsmith. *Chem. Rev.* **33**, 257–349 (Dec. 1943).

The methods of preparation, the physical and chemical data, and the industrial applications of the higher fatty acid esters of polyhydric alcohols and of polyhydroxy-ethers are reviewed. Triglycerides are not included. 572 references.

Elastic and Creep Properties

The stress-strain-time-temperature and humidity behavior of textile fibers. Edward R. Schwarz. TEXTILE RESEARCH **13**, 2–8 (Nov. 1943).

The recent publication issued by the Textile Foundation, "Elastic and Creep Properties of Filamentous Materials and other High Polymers" is described and interpreted by Prof. Schwarz, under whose direction this important research project was conducted. The principles of creep are explained and some practical applications of these principles to the manufacture of textiles are given.

Molecular Weight of Cellulose

Molecular weight of native cellulose. Nils Gralén and The. Svedberg. *Nature* **152**, 625 (Nov. 27, 1943). (Through *Bull. Inst. Paper Chem.* **14**, 166.)

Preliminary results are given on the measurement of the sedimentation and diffusion velocities of cellulose in cuprammonium solution, using a nitrogen atmosphere. For reliable results, the values must be extrapolated to zero concentration of cellulose. The molecular weights were calculated by the formula of Svedberg. The following results are reported for molecular weight (all values multipled by 10^6) and degree of polymerization: unbleached cotton cellulose, 1.50, 9200; raw Georgia cotton 1.00, 6200; nettle fiber cellulose, 1.76, 10,800; ramie, 1.84, 11,300; sulfite wood pulp, 0.46, 2,900. The results do not correspond to Staudinger's hypothesis of a linear relation between relative viscosity and molecular weight; the latter increases much faster than the viscosity. From the sedimentation data, it appears that, the longer the molecules, the more they tend to become curled.

X–Ray Examination of Cellulose

The reaction metal hydroxide solution-cellulose fiber. IV. X-ray optical examination of the lattice transformation in fibrous hydrated cellulose regenerated from a solution of natural cellulose. W. Schramek, O. Succolowsky and Elfriede Seidel. *Kolloid Z.* **100**, No. 2: 299–303 (Aug. 1942); *C. A.* **37**, No. 13: 3932 July 10, 1943). (Through *Bull. Inst. Paper Chem.* **14**, 195.)

The action of aqueous caustic soda solutions on highly oriented regenerated cellulose fibers is compared with their action on natural cellulose fibers. With either fiber 1–8% caustic soda does not change the lattice constants of the hydrated cellulose. With the regenerated fiber and 8.5% caustic

soda, transformation of the crystalline region begins. At 10% pure Na-cellulose I is formed. Regenerated cellulose is completely transformed into alkali cellulose by 9-18% caustic soda, native cellulose only partly. With mercerized natural fibers, swelling increases with caustic soda concentration up to 18%; with regenerated cellulose fibers the maximum swelling is at 9-10% caustic soda. The transformation to Na-cellulose I is reversible as demonstrated by the reversibility of the swelling process and ability to form interference patterns as the caustic soda concentration falls from 18–9%. Below 9%, reversibility is no longer evident, for with either native or regenerated cellulose fibers the degradation of Na-cellulose I leads to Na-cellulose IV.

Solubilizing Action of Soap

Solubilization and the colloidal micelles in soap solution. J. W. McBain and K. E. Johnson. *J. Am. Chem. Soc.* **66**, 9–13 (Jan. 1944).

The solubilization of water insoluble dye by four potassium soaps has been measured for equilibrium conditions over a range of concentrations. The solubilization increases so rapidly with the higher soaps as to cast doubt upon the suggestion that it is a solution in the hydrocarbon fraction of the molecule, but rather to favor its incorporation between the layers of lamellar micelles. Potassium chloride not only greatly increases the solubilizing power of fully formed micelles, but produces in dilute solution micelles of still higher solubilizing power.

Modification of Starch

The structure of the "B" modification of starch from film and fiber diffraction diagrams. R. E. Rundle, Lester Daasch, and Dexter French. *J. Am. Chem. Soc.* **66**, 130–4 (Jan. 1944).

Methods for preparing films and fibers of the "B" modifications of starch are outlined. Film and fiber diffraction patterns of the "B" modification of starch have been prepared. The fiber axis is 10.6 A. A new unit cell for the "B" modification has been found, with $a_o = 16.0$, $b_o = 10.6$, $c_o = 9.2$ A. The structure is probably orthorhombic. There are eight glucose residues per unit; the density of the crystalling portion of starch is about 1.6 g./cc. A rough structure of the "B" modification of starch has been proposed on the basis of the unit cell dimensions and qualitative consideration of the intensities. It is pointed out that plasticizers useful in producing starch fibers generally alter the starch structure materially and, unlike the case of cellulose, the fiber spacing of starch is easily altered by treatment of the starch.

White Potato Starches

White potato starches. P. E. Meiss, R. H. Treadway, and Lee T. Smith. *Ind. and Eng. Chem.* **36**, 159–163 (Feb. 1944).

Conditions of paste formation required for making reproducible consistency measurements on domestic white potato starches are discussed. Several factors influencing the consistency of the paste, such as method of drying starch and the presence of water-soluble substances, have been studied. Consistency data are interpreted to yield information regarding the extent of degradation and/or the amount of soluble material present in starch samples. Twenty-four samples of potato starch produced by factories in the United States during the 1941–42 season have been examined by various chemical and physical tests. The consistency and particle-size measurements are discussed; the particle-size distribution of western potato starches is found to be different from that of Maine starches, but there is no relation between particle-size distribution and method of manufacture. Some conclusions are drawn regarding the influences of manufacturing methods and the water used in manufacture on the quality of starch.

Viscosity and Structure

Viscosity and structure of pure hydrocarbons. Henry A. Kierstead and John Turkevich. *J. Chem. Phys.* **12**, 24–7 (Jan. 1944).

Values of the two constants, A and E, of the Arrhenius equation for fluidity, $\Phi = A^{-E/kt}$, are tabulated for a number of hydrocarbons. The effect on the values of

A and E of the following structural features are noted: addition of CH_2—, branching of chain, position of side chain, chain length, unsaturation, ring closure, ring cleavage, and condensed ring structure.

Structure of Wool

The structure and reactivity of the wool fiber 8. The fine structure of wool keratin. H. Nowotny and H. Zahn. *Z. physik. Chem.* **51** B, No. 5: 265–80 (June 1942) cf. *B. I. P. C.* **14**, 35. (Through *Bull. Inst. of Paper Chem.* **14**, 194.)

The authors discuss the x-ray structure of keratin and the part played by laminar structural elements, proposing grid formation of the polypeptide chains in the direction of the "backbone" [cf. Astbury, Chemistry & Industry 60: 491–7 (1941)]. The occurrence and significance of laminar structures in cellulose, natural silk, and collagen are mentioned.

Structure of Wool

The structure and chemistry of wool fibers. E. Elod, H. Nowotny and H. Zahn. *Kolloid-Z.* **100**, No. 2: 283–98 (Aug. 1942). (Through *Bull. Inst. of Paper Chem.* **14**, 194.)

Horse hair is decomposed by trypsin into long fibrillar structures (macrofibrils) which form an intermediate stage between the intact fibers and the spindle cells. Keratin has a laminar structure of polypeptide chains; examples from various sources show that different kinds of linkages are present with varied reactivities; reactions which attack one individual linkage system exclusively are very rare. Examples of cystine-splitting reactions are reduction of wool with thioglycolic acid in the vicinity of the isoelectric point and the reaction of wool with mercury nitrate at room temperature. In a period of four weeks about one-third of the cystine bonds react without a noticeable decrease in the mechanical strength properties. The reaction with alkalies can be influenced to the extent that, in the initial stages, the reaction with the cystine groups predominates. Non-oxidizing acids, such as 1.1 N hydrochloride acid at 80° C., react specifically with the peptide linkages and cause a strong mechanical weakening of the fiber; ammonia is split off at the same time. Most wool reactions do not take place with individual protein linkages. In the case of aqueous hydrogen peroxide solutions, hot water, or metals (such as mercury and cadmium), both the cystine linkages and the wool nitrogen are attacked. It is not possible to determine the fiber strength or degree of damage by the number of intact S-S groups; the magnitude of these factors depends entirely upon the pretreatment of the wool. The fiber strength depends primarily upon the number of intact peptide bonds. 51 references.

DYEING: BLEACHING: FINISHING

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New Azo Dyes

A new class of substantive azo dyes. C. F. H. Allen and F. P. Pingert. *J. Org. Chem.* **9**, 50–4 (Jan. 1944).

A new class of substantive dyes derived from the ortho and para terphenyls are described. It is suggested that there are two factors that contribute to substantivity, namely, a crossed-conjugated system of multiple linkages, and particle size.

Color Matching

Color matching—What the dyer sees. E. Waters. *J. Soc. Dyers and Colourists* **59**, 261–5 (Dec. 1943).

It was established experimentally that the physicists term "hue" (dominant wave length) could be properly used for the colourists term "shade." The other two attributes of a dyed sample which may be referred to by the dyer as "strength" and "dullness," and by the physicist as "purity" and "lightness" or "luminosity" are closely interrelated and changes in the first two involve simultaneous changes in the latter two. In order to determine whether the observer estimated strength on the basis of purity or on the basis of lightness, a set of samples was devised and submitted to a group of 26 experienced colorists and 12 non-colorists for classification. Results showed that although it was probable that no distinct resolution of the two variables

took place, the trained observer assessed strength using the property of purity as a guide whereas the non-colorist used lightness. It was of interest, and further evidence of the distinction between the dimensions of hue and strength, that the experienced colorists refused to estimate differences in strength of patterns in which the shade varied by more than two "steps of just perceptible difference in hue."

Dye Mixtures

The absorption by cellulose of mixtures of direct cotton dyes. S. M. Neale and W. A. Stringfellow. *J. Soc. Dyers and Colourists* **59**, 241–5 (Nov. 1943).

Investigation has shown that the behavior of mixtures of direct cotton dyes cannot, contrary to common belief, be inferred from the dyeing properties of the individual dyes. It has been found, in general, that (1) the spectra of mixtures in water are not additive, (2) when mixtures are dyed on cotton, the absorption of at least one component, relative to its absorption when dyed singly, is reduced markedly below the value to be expected merely from the competition of the two dyes for the available surface, (3) this interference of one dye with the absorption of a second dye increases as the temperature is lowered, and (4) the half-dyeing time for direct dyes dyed in a mixture is up to twice as long as that for each dye applied singly. Explanation for this behavior of dye mixtures is attributed to a mutual interaction between the dyes, probably through the operation of resonance bonds or residual valency forces similar to those responsible for anchoring the dye on to the hydroxyl groups of cellulose. It was observed that mixtures of dyes in 25% pyridine solutions gave substantially additive spectra. Pyridine is believed to be a suitable medium for the "saturation" of residual valencies and thus prevents both their mutual interaction (accounting for the suppression of the spectral interference effect in pyridine solutions) and their absorption by cellulose (accounting for the stripping effect of pyridine). Pairs of dyes which are known to cause trouble in mixture dyeings, e.g., Chlorazol Sky Blue FF (C.I. 518) and Chysophenine G, were found to show the largest shift in absorption spectra and to be the most affected by change in temperature with regard to their absorption ratio by cellulose.

Textile Printing

Textile printing. Part II—The reduction potentials of prints during steaming. A. B. Meggy and J. Rogers. *J. Society Dyers and Colourists* **59**, 215–17 (Oct. 1943).

The printing properties of many vat dyes can be improved by increasing the concentration of sodium sulfoxylate-formaldehyde in the printing paste, often to a point very greatly in excess of the amount necessary for reduction of the vat dye. In order to determine whether this phenomenon might be explained on the grounds that the reduction potential varied with the concentration of the sodium sulfoxylate-formaldehyde and that a minimum potential was necessary for each dye to bring about complete reduction, a method was worked out to determine the reduction potential of vat dye prints during ageing. It was found that as the concentration of the sodium sulfoxylate formaldehyde increases from 4% to 12% the reduction potential drops from −630 to −670 mv. on the hydrogen electrode scale. It is pointed out that for most favorable printing conditions the reduction potential on the print should be more negative than the critical reduction potential of the dye since if this is so the rate of reduction will then be independent of the rate of absorption of dye by the fiber.

FIBERS: YARNS: FABRICS: MECHANICAL PROCESSES

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Milling Shrinkage

Milling shrinkage of union fabrics. Whewell, Eid, Kokmen and Lui. *J. Soc. Dyers and Colourists* **59**, 233–40 (Nov. 1943).

The shrinkage on milling of cloth having a common cotton warp and a filling of yarns comprised of various blends of (1) chlorinated (unshrinkable) wool, (2) cellulose acetate, (3) casein fiber, (4) Ardil (a peanut protein fiber), (5) Fibro (viscose rayon

staple) and (6) Rayolanda X (modified or "animalized" viscose rayon staple), all with wool, and prepared on the worsted system, was investigated. Results of this study showed that introduction of even small amounts of untreated wool into fabrics of unshrinkable wool (to increase wear resistance) was of profound effect upon resistance to shrinkage and therefore impracticable; when acetate rayon was mixed with wool the milling action was very much decreased; blends of wool and casein fibers in various proportions had excellent milling qualities, the casein fiber increasing the shrinking tendency of the cloth; Ardil peanut protein fiber behaved similarly to casein fiber; the incorporation of both Fibro and Rayolanda X in wool fabrics reduce the shrinking power, the Fibro to a much greater extent, however, than the Rayolanda X. The complicating factor of cloth structure is discussed.

Copper Soaps

Copper soaps, as rot-proofing agents on fabrics. Paul B. Marsh, Glenn A. Greathouse, Katharina Bollenbacher, and Mary L. Butler. *Ind. & Eng. Chem.* **36**, 176–181 (Feb. 1944).

Copper naphthenate prevents rotting of cotton fabric in soil at lower concentrations on the fabric than do copper oleate, copper "tallate," or copper hydrogenated resinate. Several methods have demonstrated that the high preservative capacity of copper naphthenate in contact with soils is related to the fact that naphthenic acid itself is a potent fungicide. Various factors affecting the behavior of copper preservatives in contact with soils are studied. They include solubilization by acid hydrolysis and by complex formation, and deactivation by chemical combination. Data from pure culture test procedures are contrasted with the results obtained by exposure to soils.

Rayon Weaving

Causes of warp and weft (filling) breakages in rayon weaving. Anon. *Silk J. Rayon World* **20**, 22–23 (Sept. 1943).

Though rayon has made great strides forward in recent years, filament rayon remains the most sensitive yarn that goes through the process of weaving. Breakage of the warp threads or filling may be due to a variety of causes, many of which are here described. It is stated that filling breakages generally arise from the same sources as in cotton weaving, a few exceptions are noted.

MISCELLANEOUS

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Corporate Research and Development

Planning corporate research and development. H. Wickliffe Rose. **Inter-research—the present need.** TEXTILE RESEARCH **13**, 4–8 (June 1943); **Research and the patent system.** Ibid. **13**, 9-16 (July 1943); 2–8 (Aug. 1943); 10–17 (Sept. 1943); **The future of the corporation.** Ibid. **13**, 5–12 (Oct. 1943). (Limited number of reprints available of series, bound together in pamphlet form.)

In this series of related articles the importance of research in the corporate structure is discussed and, in particular, the workings of the patent system as it affects the individual research worker and the corporation are described in detail. This series of articles is particularly timely in view of the prevalence of attacks upon the patent system and proposals for revision of the system. The author states "the importance of adequately assuring the element of time required for the development of a new process or a new machine can hardly be overestimated. For this affects not only the individual research worker and inventor but also the continuity of life for the corporate structure."

Future Trends in Textile Organization

Will post-war organization of textile companies be vertical or horizontal? H. S. Davis. TEXTILE RESEARCH **13**, 30-5 (Dec. 1943).

This article builds on a comprehensive study of the subject which was sponsored by Textile Research Institute and the Textile Foundation in the late 30's. The report of this study, titled "Vertical Integration in the Textile Industries," was prepared by the Industrial Research Department, Wharton School, University of

Pennsylvania. The present article discusses advantages of and dangers in the vertical type of organization and cites recent notable examples, namely the Atlantic Rayon Corporation's market-wise expansion and the backward-taper type of organization represented by S. Robert Stone, Inc., with its expansion supply-wise.

Filtration Developments

Filtration developments in rayon production. A. G. Arend. *Silk J. Rayon World* **20**, 22–23, 41 (Oct. 1943).

A critical description is given of the various types of filters used in the rayon industry, particularly the popular filter-presses. A new type of filter is described which was introduced just prior to the war, and which has been considered for rayon manufacture. This is the rotary vacuum filter with pressure connection and cord attachment, which is said to be an improvement over older vacuum type filters. Although described in detail, no diagram of this filter is included.

Mothproofing

The mothproofing of wool. Hartley, Elsworth and Barritt. *J. Soc. Dyers and Colourists* **59**, 266–271 (Dec. 1943).

The life cycle of the clothes moth, its food and digestive system and breeding are described. Methods of test for resistance to larval attack are outlined; in general these consist of placing active larvae in contact with a test sample for a given time under standard conditions and then assessing damage either visually, by weighing the sample and/or the excrement produced, by determination of uric acid, or by counting larvae remaining alive. Quantitative methods were found of limited value unless all tests were made on the same type of fabric. The problem of moth proofing offers two lines of approach, viz., (1) adding to the material a substance which will either poison the larvae or render the material indigestible for it, or (2) to modify the keratin structure so that it is no longer capable of digestion by the larvae. A chronological outline of mothproofing methods is presented. The results of washing tests on material proofed by various fluorine treatments indicated that these varied from moderate to extremely poor in washing fastness; 0.2–0.3% fluorine has been found necessary for satisfactory protection. The work of Geiger, Kobayashi and Harris on modification of the keratin structure is discussed.

New Staple Fiber Process

Rayon staple fiber made by new electrical process eliminating cutting and carding. Anon. *Silk J. Rayon World* **20**, 28 (Oct. 1943).

Experiments are proceeding in Germany, according to information coming through Switzerland, to produce staple fiber yarns from viscose, cuprammonium or cellulose acetate on an entirely new basis. The reservoir containing the spinning solution is connected to one pole of a supply of high-voltage direct current. Two wires below the jet are connected to the other pole. As the solution emerges from the jet the circuit is completed and the streams of solution are broken up into short lengths by the action of the field. As the solvent evaporates, short fibers are formed which are oriented by the electric field and transferred away as a coherent sliver. The staple length may be varied by modification in the circuit. A good yarn has been reported to have been spun from these slivers.

Oil Corrosivity

Corrosivity of lubricating oils—existent and potential. George W. Waters and Hugh D. Burnham. *Ind. Eng. Chem.* **36**, 263–71 (March 1944).

Bearing corrosion is analyzed into two concepts: "existent corrosivity" which occurs by virtue of the instantaneous chemical state of a lubricant and "potential corrosivity" which occurs under conditions, representative of those of service, which lead to the simultaneous oxidation of the oil. The effects upon both types of corrosivity of temperature, time, nature of oil, concentration of reactions, and physical factors of tests are described. The important function of protective lacquer films in

preventing corrosion and the interference with their action by detegents are demonstrated.

Cotton for Marine Caulking

Navy approves cotton for marine caulking. J. Lester Crane and Simon Williams. *Cotton* **108**, 93–5 (Feb. 1944).

A study was made to determine the suitability of cotton for marine caulking. The use of cotton for this purpose in conjunction with oakum is not new but its effectiveness alone was in question. Tests were conducted by the Navy on samples submitted by the National Cotton Council along with Navy oakum and standard Navy cotton. Impregnated and untreated cotton was compared in the tests with Navy oakum and Navy standard cotton and results are shown. The results of the tests as a whole clearly demonstrate the adaptability of cotton to marine caulking.

Electronics

ABC's of electronics. W. D. Cockrell. *Chem. Ind.* **64**, 56–8 (Jan. 1944).

The person unfamiliar with electronics is apt to be a little mystified and confused by the glowing promises of electronic things to come that are appearing so frequently in both the general and technical press. Actually, the electron tube is a sample mechanism based on the laws covered in high school physics. Because its applications in the chemical industry are multiplying so rapidly, an attempt is made here to describe its functioning in terms of the essentially simple phenomenon that it is.

Tall Oil

Tall oil for the textile industry. R. Hastings. *Am. Dyestuff Reptr.* **33**, 25–6, 50 (Jan. 17, 1944).

Tall oil, a product of the alkaline paper pulp industry, has many applications in textile operations. The present paper briefly reviews the source and composition of tall oil, and describes how it may be converted into soap for scouring wool, rayon, and cotton linters, for the kier boiling of cotton for the degumming of silk and for the depitching of rayon pulps. Tall oil sulfonates readily forming a product similar to the turkey red oil used by textile plants as a textile wetting, softening, and lubricating agent. Metal soaps of tall oil are useful for waterproofing and mildewproofing textile fabrics.

Luminescent Pigments

Luminescent pigments. G. F. A. Stutz. *Paper Trade J.* **118**, 34–6 (March 2, 1944).

Both the fluorescent and phosphorescent types of luminescent pigments are defined and generally described. Exciting light sources for such pigments are also described. Since practical applications in paper and printing ink are mostly limited to the inorganic fluorescent pigments, zinc and zinc and cadmium sulphides, these pigments are described in most detail and their properties given. Chemical characteristics, suitable vehicles, fluorescent color, daylight color, fluorescent brightness, and afterglow are discussed.

Synthetic Bristles

Synthetic bristles and electrostatic excitability. F. Broihan. *Brit. Plastics* **15**, 426–28 (Dec. 1943).

The high electrostatic charges restrict the scope of application of synthetic bristles. Though sparks able to cause ignition could not be drawn from the synthetic bristles themselves, it may happen that the charged bristles may relieve electrostatic charges on insulated metal parts by electrostatic induction. When discharged in rooms liable to the occurrence of explosions, these charges may cause the destruction of property and danger to human life.

Shear Strength of Plastics

Shear strength of plastic materials. R. T. Schwartz and Edward Dugger, Jr. *Modern Plastics* **21**, 117–21 (March 1944).

An investigation was made to determine the shear strength of a number of thermoplastic and thermosetting plastic materials. Materials investigated included laminates of textiles, paper and glass. Textiles used included fine and coarse weave cotton fabrics, muslin, and cotton duck. Test results are tabulated and list shear, tensile, and compressive strengths.